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Bud Development in the 1982-83 Overwintered Black Spruce Container Seedling Crop

by

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Introduction

Bud development in container stock can be increased using Extended Greenhouse Culture (Colombo [illegible] Colombo et al. 1984) by keeping seedlings in the greenhouse during hardening at the optimum temperature range (20-30°C) for needle primordia formation (Pollard and Logan 1977, 1979). The number of needle primordia laid down during bud development has been increased by 22 percent in jack pine (Pinus banksiana Lamb.) and by nearly 300 percent in black spruce (Picea mariana (Mill.) B.S.P.) when the Extended Greenhouse Culture procedure was used (Colombo 1982).

With the ever increasing emphasis on the use of container stock it is important to document current levels of bud development in overwintered spruce container stock. This paper describes the status of bud development in the 1982-83 overwintered black spruce crop in Ontario and discusses some of the factors affecting bud development in spruce container stock. This information provides baseline data for nurserymen to evaluate the quality of their stock in future years.

Materials and Methods

Samples of terminal buds were collected between May 4 and 10, 1983, from overwintered black spruce container seedlings at forest tree nurseries throughout Ontario. Samples representative of each seedlot and greenhouse were collected from the Ministry of Natural Resources Tree Nurseries at Dryden (49°45'N Lat., 92°45'W Long.), Swastika (48°06'N Lat., 80°16'W Long.) and Thunder Bay (48°25'N Lat., 89°15'W Long.). In addition, samples were taken at two private container tree seedling nurseries, Hill's Greenhouses Ltd. in Thunder Bay and Energreen Enterprises Inc. at Ramore (48°26'N Lat., 80°20'W Long.).

At each nursery 26 shoot tips were collected from each seedlot and greenhouse by excising 2 to 3 cm of the terminal shoot of each selected seedling. Two seedlings were selected randomly within each of 13 trays along the length of the centre aisle of each overwintering bed. Immediately after collection the needles were stripped from the collected shoot tips leaving only the stem and terminal bud. The shoot tips were then placed in a vial containing 90% ethanol.

Buds were dissected as described elsewhere (Pollard 1973, Colombo et al. 1982). The budscales were removed to expose the apical meristem, upon which rest the needle primordia and the following season's "telescoped"-shoot. Needle primordia are arranged in spiral rows upon the apical meristem. The total number of needle primordia in each bud was estimated by calculating the average number of needle primordia in two or three spiral rows, and multiplying this number by the number of spiral rows present.

Further information may be obtained from:

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Results and Discussion

The provincial average for bud development in black spruce container stock grown in 1982 and overwintered until the spring of 1983 was 148 needle primordia. By region, the averages were 167 in the Northern, 159 in the North Central, and 103 needle primordia in the Northwestern (Figs. 1-3). Average bud development in the private growers at Hill's in Thunder Bay and Energreen in Ramore was 213 and 197 needle primordia respectively.

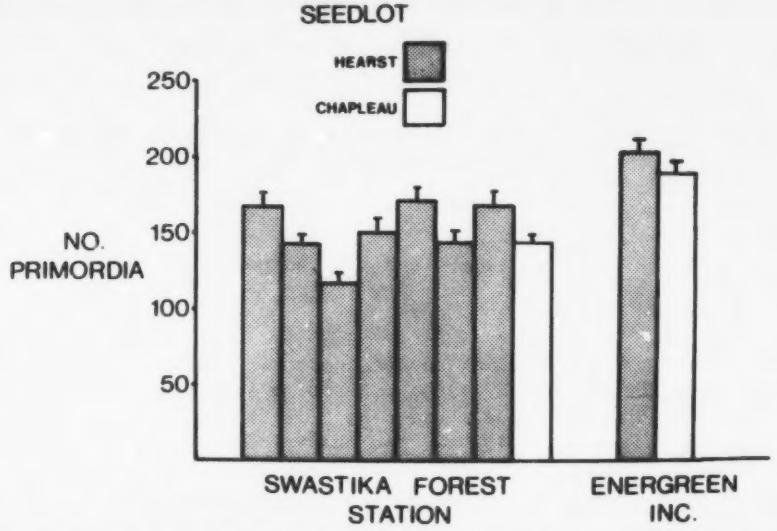

Figure 1 Average bud development in black spruce container seedlings from two nurseries in the Northern Region. Each bar represents a different greenhouse. Lines heading bars are standard error of the mean.

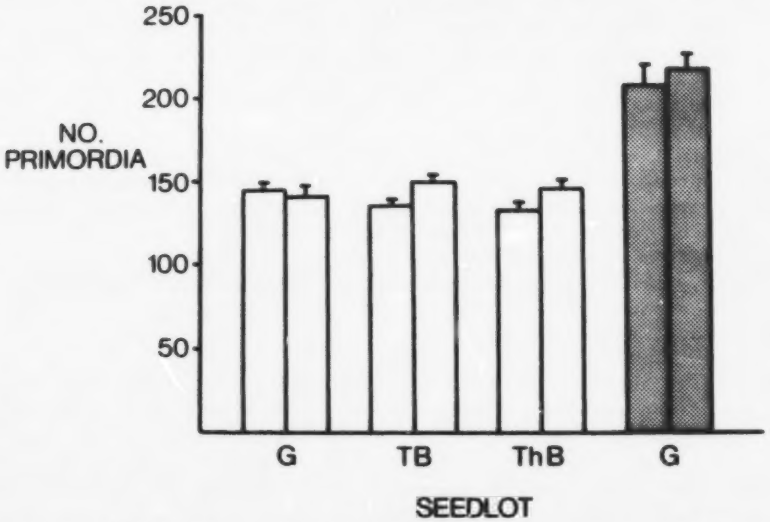

Figure 2 Average bud development in black spruce container seedlings from two nurseries in the North Central Region. Open bars are averages for seedlings from the OMNR Thunder Bay Forest Station. Shaded bars are averages for seedlings from Hill's Greenhouses Inc. Each bar represents a different greenhouse. Lines heading bars are standard error of the mean. Seedlots are: G - Geraldton, TB - Terrace Bay, ThB - Thunder Bay.

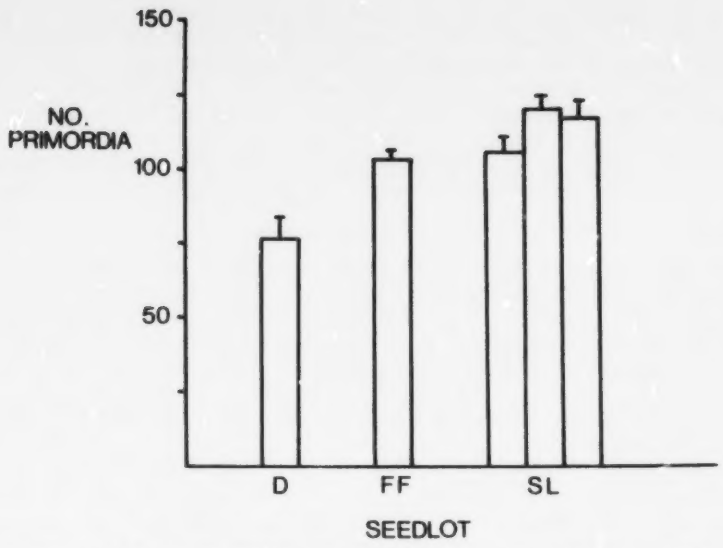

Figure 3 Average bud development in black spruce container seedlings from the Northwestern Region's Dryden Tree Nursery. Each bar represents a different greenhouse. Lines heading bars are standard error of the mean. Seedlots are: D - Dryden, FF - Fort Frances, SL - Sioux Lookout.

Differences in bud development were attributable primarily to differences in cultural regime between nurseries (e.g., date of sowing, fertilizer regimes). Seedlot and greenhouse influences were comparatively slight. For example, in the North Central Region, seedlings of the Geraldton seedlot were grown in two greenhouses at Hill's Nursery (average 213 primordia) and also in two greenhouses at the Ministry of Natural Resources Nursery in Thunder Bay (average 142 primorida) (Fig. 2). Larger buds at Hill's Nursery were attributable to the larger seedlings which resulted from the earlier sowing date (May 10, 1982) compared with the OMNR Thunder Bay nursery, at which seedlings were not sown until June 2, 1982.

The potential for bud development is greatest in seedlings with the largest diameter at the time of bud initiation (Baxter and Cannell 1978, Cannell 1976, Pollard and Logan 1977). Bud development will cease under optimal conditions only when the limitation of the size of the apical meristem is reached. The larger the apical meristem, determined largely by seedling diameter, the greater will be the maximum number of needle primordia which can form. The upper limit to first-year bud development in spruce has not yet been fully determined, although buds of black spruce container seedlings with up to 450 primordia have been observed in our work.

When Extended Greenhouse Culture is used to harden spruce container stock for overwintering, seedlings remain inside the greenhouse until high levels of frost hardiness are achieved and bud development is completed (Colombo 1982, Colombo et al. 1984). The high cost of operating greenhouses in northern Ontario during late autumn, however, makes early bud initiation a favourable option. Buds are initiated in first-year spruce seedlings in the greenhouse in response to declining daylengths (Heide 1974). However, bud initiation can be hastened or delayed by varying factors such as nitrogen nutrition (Cheung 1973), temperature (Cheung 1973, Heide 1974) and photoperiod (Cheung 1973, Dormling 1973, Heide 1974). In particular, the use of short day treatment for inducing bud initiation and speeding the time of safe removal from the greenhouse appears promising. Early bud initiation in response to short day treatment will reduce the potential number of needle primordia which can form, if seedlings are of small diameter at the time of bud initiation. It is therefore important that growing regimes be adjusted to provide the largest seedlings possible at the time short day treatment is begun.

The number of needle primordia which form can be affected by environmental and cultural factors during bud development. Conditions reported to maximize bud development are temperatures of 20 to 30°C, light intensities of 10 000 to 20 000 lux, soil moisture at field capacity, and application of a "complete" fertilizer including nitrogen (Pollard and Logan 1977, 1979). It is unclear whether these factors affect bud development directly, or if they increase bud development because they increase seedling diameter. Generally, conditions which most favour shoot elongation will also result in seedlings with buds containing the greatest number of needle primordia.

Although large differences in bud development between seedlings raised at different nurseries were observed, only at Swastika was improved bud development an objective of the hardening regime. In 1983, using Extended Greenhouse Culture, the average bud development in black spruce container stock at Swastika rose to 148 needle primordia, compared to only 75 needle primordia in 1982 (Colombo et al. 1982).

By using Extended Greenhouse Culture and optimizing the conditions for bud development, it should be possible to routinely produce seedlings with buds containing over 250 needle primordia, an almost four-fold increase over the 1981 levels at Swastika. The results from monitoring presented here should serve as a basis for evaluating future improvements in bud development.

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